

# The Big Picture: Obesity, Consumption, and Food Production

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## ABSTRACT

Reducing the percentage of Americans who are either overweight or obese to meet public health objectives may influence agricultural production. The authors' results show that reducing aggregate consumption by 6% to meet public health objectives with no increase in overall physical activity could reduce production of agricultural commodities and reduce net returns to producers by \$3.5 billion. However, if consumption is reduced by 2% concomitantly with a marginal increase in physical activity, similar health outcomes could be achieved at much less cost (\$1.3 billion). Conversely, continuing obesity trends may enhance returns to agricultural production by \$1.3 billion annually. Changes in agricultural activities would likely be variable across the landscape. Results indicate that the largest potential changes in agricultural producer net returns (positive or negative) would occur in the Corn Belt and the Lake States. There, crop acreage could fall by as much as 650,000 hectares. [EconLit citations: Q130, Q180] © 2006 Wiley Periodicals, Inc.

## 1. INTRODUCTION

In 1999 to 2000, 65% of American adults were overweight and over one third were both overweight and obese (Surgeon General, 2004). The Centers for Disease Control and Prevention (CDC) estimated that the prevalence of obesity in the United States increased from 14.5% to 30.9% between 1971 and 2000 (CDC, 2003). According to recent estimates (Surgeon General, 2004), obesity accounts for \$117 billion a year in direct and indirect economic costs, is associated with 365,000 deaths each year, and may soon overtake tobacco as the leading cause of preventable deaths (Mokdad, Marks, Stroup, & Gerberding, 2005). Because of these trends, obesity treatment and prevention have become major public health objectives. In November 2000, the U.S. Department of Health and Human Services (USDHHS) published "Healthy People 2010"—hereafter referred to as HP 2010—setting forth objectives to improve health and reduce the incidence of diseases associated with obesity. Among these are to increase the percentage of the population with a healthy weight to 60%, decrease the percentage of the population who are obese to no more than 15%, and increase the percentage of the population who are active (USDHHS, 2000).

Past research shows that U.S. diets would need to change significantly to conform to the U.S. Department of Agriculture's (USDA's) former Food Guide Pyramid (Kantor,

1998; McNamara, Ranney, Kantor, & Krebs-Smith, 1999) and this change would require adjustments in agricultural production, prices, and trade (Young & Kantor, 1998). Recently, Buzby, Farah, and Vocke (2005) investigated how response to the *Dietary Guidelines for Americans, 2005* (U.S. Department of Health and Human Services [USDHHS] and U.S. Department of Agriculture, 2005) recommendations on whole-grain intake may affect domestic grain production. The 2005 Guidelines recommend that people over 2 years old eat roughly half of their 5 to 10 daily servings of grains as whole grains. They estimated that if manufacturers increased whole-wheat flour production to the *Guidelines'* recommended 50% of total flour production, demand for domestic wheat flour could drop by approximately 13%. Buzby et al. are currently investigating the potential impact on agriculture if Americans also eat recommended amounts of fruits, vegetables, and dairy products. To date, however, there has been little analysis of how much aggregate food consumption in the United States would need to change to generate changes in weight distribution (see McNamara et al., 1999). In turn, there has been very little analysis of how these changes could affect domestic agricultural production and producer surplus. It may be that agricultural producers would face decreasing returns to production if Americans significantly reduce consumption to achieve healthier bodyweights. A corollary to this line of reasoning is that a continuation of the current trends in obesity could lead to higher returns for the agricultural sector.

Given the broad interest in the growing U.S. health consequences attributed to obesity, the objectives of this research are to estimate the impacts of changing food consumption on production patterns and farm incomes. Because of uncertainty over trends in eating habits, we assess the impacts on producers under several scenarios for future eating habits. Using the 1999–2000 National Health and Nutrition Examination Survey (NHANES; CDC, 2003), we estimate alternative distributions of caloric intake for U.S. men and women given changes in eating and exercise habits over the next 6 years. These distributions allow us to estimate aggregate changes in domestic food demand and to incorporate this into a model of U.S. agricultural production. Given the adjustments in sector production across regions, we consider how changing dietary and exercise habits may affect farm incomes.

## 2 SHIFTING LEVELS OF CONSUMER DEMAND

To estimate how much aggregate consumption in the United States would change under each scenario, we use NHANES 1999–2000 data (CDC, 2003). Each year this survey collects information on dietary intake, medical information, and sociodemographic characteristics for approximately 5,000 civilian, noninstitutionalized persons in the United States. Our analysis includes adults aged 20 and above and uses NHANES data for information on an individual's age, gender, height and bodyweight.<sup>1</sup> However, using this survey's dietary intake data to estimate how much less Americans would need to eat to meet the HP 2010 objectives is problematic. The survey collects a single day of dietary information, which is inadequate to provide reliable estimates of an individual's usual dietary intake (Palaniappan, Cue, Payette, & Gray-Donald, 2003). Moreover, individuals tend to underreport the amount of food they consume (McCrory, Hajduk, & Roberts, 2002; Variyam, 2003).

<sup>1</sup>We exclude pregnant women or amputees in our sample because their measured BMI is less likely to reflect their true weight status.

TABLE 1. Distribution of Population Under Each Scenario

Scenario <sup>a</sup>	Body mass index (BMI) <sup>b</sup>			Physical activity classification <sup>c</sup>		
	Healthy weight	Over-weight	Obese	Inactive	Low active	Active
Baseline—men	33.00	39.30	27.70	40.00	14.00	15.00
Baseline—women	38.00	28.00	34.00	40.00	14.00	15.00
Scenario 1	60.00	25.00	15.00	40.00	14.00	15.00
Scenario 2	60.00	25.00	15.00	20.00	50.00	30.00
Scenario 3—men <sup>d</sup>	23.75	35.15	41.10	40.00	14.00	15.00
Scenario 3—women	19.70	31.70	48.60	40.00	14.00	15.00

<sup>a</sup>Baseline values are calculated from the 1999–2000 NHANES data; Scenario 1: BMI distribution of the population in 2010 meets the HP 2010 objectives because individuals consume fewer calories but do not change physical activity; Scenario 2: BMI distribution of the population in 2010 meets the HP 2010 objectives because individuals both consume fewer calories and increase their level of physical activity; and Scenario 3: BMI distribution of the population in 2010 meets projections based on the current increase in the percent of the population that is overweight or obese, by gender because individuals consume more calories and do not change their level of physical activity.

<sup>b</sup>Body Mass Index (BMI) is an individual's weight (in kilograms) divided by his or her height squared (in meters). An Individual is considered to have a healthy body weight if his or her BMI is in the range of 18.5 and 24.9. An individual is considered to be overweight if his or her BMI is equal to 25 or more. An individual is considered to be obese if his or her BMI is 30 or higher.

<sup>c</sup>An individual is considered 'inactive' if he or she reports no physical activity beyond that of independent living. An individual is considered to be 'low active' if he or she engages in physical activity equivalent to 1.5 to 3 miles per day at 3 to 4 miles per hour. An individual is considered to be 'active' if he or she engages in physical activity that is equivalent to walking more than 3 miles per day at 3 to 4 miles per hour (USDA, Center for Food Policy and Promotion, 2004). In each scenario, the proportion of individuals in a given activity level are derived from either estimated or target levels listed in "Healthy People 2010"

<sup>d</sup>This projection assumes that the portion of the population falling into either the overweight and obese category increases at the current rate (the percentage change between NHANES 1988–1994 and NHANES 1999–2000).

Therefore, we circumvent these problems by using an individual's measured body-weight, height, and age to calculate the number of calories needed to maintain one's current bodyweight. We then estimate individuals' 2010 bodyweight under two different paths: Americans meet the HP 2010 objectives or obesity trends continue. We assume that only the quantity of food eaten changes and that the relative shares of items in the U.S. food basket remain unchanged. Using this assumption and the biological relationship among energy (caloric) intake, energy expenditures, and weight gain, we estimate individuals' future caloric requirements under three specific scenarios.

- Americans meet the HP 2010 objectives by eating less, but make no changes in their level of physical activity (Scenario 1, Table 1).
- Americans meet the HP 2010 objectives by both eating less and increasing their physical activity (Scenario 2, Table 1).
- The portion of the population that is either overweight or obese in 2010 increases because of increased intake and no change in physical activity (Scenario 3, Table 1).<sup>2</sup>

<sup>2</sup>This projection assumes that the portion of the population falling into either the overweight and obese category increases at the current rate (determined by the National Health and Nutrition Examination Survey 1988–1994 and NHANES 1999–2000).

Scenarios 1 and 2 differ only in the assumptions made about how people meet the HP 2010 weight objectives. In Scenario 1, they only reduce the number of calories consumed. In Scenario 2, they both reduce calories consumed and increase physical activity. Under Scenario 3, activity stays the same as it was in the NHANES 1999–2000, but individuals gain weight by consuming more calories.

Both the HP 2010 objectives for weight loss and 2010 projections for weight gain are set in terms of the population's distribution of body mass index (BMI) classifications (Table 2). To estimate how energy requirements would change under HP 2010 guidelines or if obesity trends continued, we make several simplifying assumptions. First, we assume that individuals remain in the same BMI percentile across scenarios. For example, in the baseline scenario, a woman in the 60th BMI percentile has a BMI of approximately 30, whereas in either of the HP 2010 scenarios, this individual at the 60th BMI percentile would have a BMI of 25. Second, we assume that the tails of the distribution are fixed, i.e., that those individuals who are either severely underweight (BMI <16) or morbidly obese (BMI >50) in the baseline scenario do not change their BMI. This assumption is added, both because it would be very difficult physically for people who are severely underweight to lose more weight or for people who are morbidly obese to gain more weight, but also because it serves to anchor the endpoints of our distributions. For Scenarios 1 and 2 (where individuals meet the HP 2010 objectives) we assume individuals at the 60th and 85th percentile change such that their BMIs in 2010 average 25 and 30, respectively, according to the HP 2010 recommendations. We use this same process to calculate the 2010 BMIs under Scenario 3 by assuming that the distribution of BMIs among American adults is such that women (men) below the 38th (33rd) BMI percentile have a BMI below 25, and women (men) below the 66th (72nd) BMI percentile have a BMI below 30 (see Table 1).

For each scenario, we estimate a cumulative density function (CDF) for respondents' BMIs (for men and women) using the logit model

$$\ln\left(\frac{Y_i}{1 - Y_i}\right) = \beta_0 + \beta_1 BMI_i + \varepsilon_i, \quad (1)$$

where  $Y$  is the empirical cumulative distribution function for BMI. Results indicate that this functional form provides a good fit to the data (Table 3). Given  $\hat{\beta}_0$  and  $\hat{\beta}_1$  and assumptions about exercise habits, we can calculate predicted weights for the distributions under the scenario assumptions

$$Weight_i = \hat{BMI}_i * Height_i^2, \quad (2)$$

where weight is measured in kilograms and height in meters (assuming that height does not change from observed data).

Finally, given  $Weight_i$ , we estimate each individual has predicted daily energy requirement ( $E\hat{E}R_i$ ). These EER calculations are made using the following formulas developed by the Institute of Medicine Dietary Reference Intakes (Food and Nutrition Board, 2002)

$$E\hat{E}R_i^{men} = 662 - 9.53 * Age_i + PA^{men}(15.91 * Weight_i + 539.6 * Height_i) \text{ and} \quad (3a)$$

$$E\hat{E}R_i^{women} = 354 - 6.91 * Age_i + PA^{women}(9.36 * Weight_i + 726 * Height_i), \quad (3b)$$

TABLE 2. Summary Statistics

Variables	Definition and units	Men ( <i>n</i> = 2043)		Women ( <i>n</i> = 2071)	
		Mean	Standard error	Mean	Standard error
Age	Age in years	44.30	0.42	46.26	0.52
Height	Height in centimeters	175.72	0.17	161.97	0.25
PA <sup>a</sup> <sub>1999–2000, s1, s3</sub>	Weighted average of the population's physical activity coefficient: baseline (1999–2000), scenario 1, and scenario 3	1.09	na	1.10	na
PA <sub>S2</sub>	Weighted average of the population's physical activity coefficient: scenario 2	1.13	na	1.14	na
BMI <sup>b</sup> <sub>1999–2000</sub>	Baseline (1999–2000) BMI	27.69	0.23	28.22	0.28
BMI <sub>S1, S2</sub>	BMI: scenario 1 and 2	24.52	0.22	24.31	0.26
BMI <sub>S3</sub>	BMI: scenario 3	29.00	0.21	29.44	0.26
EER <sup>c</sup> <sub>1999–2000</sub>	Baseline (1999–2000) EER in calories per day	2,753.84	12.31	2,085.91	8.96
EER <sub>S1</sub>	EER in calories per day: scenario 1	2,584.43	11.93	1,974.88	7.96
EER <sub>S2</sub>	EER in calories per day: scenario 2	2,677.19	12.36	2,057.32	8.25
EER <sub>S3</sub>	EER in calories per day: scenario 3	2,823.65	11.23	2,113.02	8.21

<sup>a</sup>The physical activity (PA) value is the population's weighted average PA score, where each PA coefficient is weighted by the percentage of population that falls into that physical activity classification.

<sup>b</sup>Body mass index (BMI) is an individual's weight in kilograms divided by his or her height in meters squared.

<sup>c</sup>The estimated energy requirement (EER) is the number of daily calories needed to maintain current body weight, given an individual's age, gender, height, weight and level of physical activity.

TABLE 3. Regression Results

Scenarios		Base		Scenarios 1 and 2		Scenario 3	
		Coefficient	Std. error	Coefficient	Std. error	Coefficient	Std. error
Men	Constant	−9.05	0.04	−7.27	0.36	−9.18	0.22
	BMI	0.33	0.00	0.30	0.01	0.32	0.01
	$R^2$	0.96		0.76		0.90	
Women	Constant	−7.03	0.04	−7.23	0.32	−8.73	0.20
	BMI	0.25	0.00	0.30	0.01	0.30	0.01
	$R^2$	0.96		0.75		0.91	

where  $PA$  is the population average physical activity score (see Table 1). As an example, in the baseline, first and third scenarios, 40% of the population will be inactive, 45% will be low active, and 15% will be active. The  $PA$  score for men who are inactive, low active, and active are 1.00, 1.11, and 1.25. As such, the physical activity value for all men in these scenarios is

$$PA^{men} = (0.4 \times 1.0) + (0.45 \times 1.11) + (0.15 \times 1.25) = 1.087. \quad (4)$$

The  $PA$  value will be different in Scenario 2 because we assume that more of the population becomes either active or low active (see Table 2). Given the assumed  $PA$  score, we calculate the 2010  $E\hat{E}Rs$  under all three scenarios (Figures 1 and 2).<sup>3</sup> For each scenario, the change in caloric demand is the percentage change in aggregate consumption from the baseline. Our estimates show that in general, the change in overall consumption is relatively small in each scenario. In Scenario 1, total consumption falls by 5.75%; in Scenario 2, it falls by 2.05%; and in Scenario 3, where individuals gain weight, aggregate consumption increases by 2.11% (see Table 4).

### 3. SIMULATING AGRICULTURAL ADJUSTMENTS

We use a regional, mathematical programming model of U.S. agriculture sectors developed by the USDA's Economic Research Service (House, McDowell, Peters, & Heimlich, 1999) to estimate how domestic production of major agricultural commodities may change under each of the 2010 scenarios. The model has been used to examine medium-term economic consequences associated with trade (Johansson, Cooper, & Vasavada, 2005), sustainable agricultural policies (Faeth, 1995), and climate-change mitigation (Peters, Lewandrowski, House, & McDowell, 2001). This model treats agriculture sectors as part of a spatially competitive, market-equilibrium system, which is partial equilibrium in the sense that U.S. agriculture does not compete with other sectors for factors of production.

We account for production of the major crop (corn, soybeans, sorghum, oats, barley, wheat, cotton, rice, hay, silage) and livestock enterprises (beef, dairy, swine, and poultry) comprising approximately 75% of crop production and more than 90% of livestock production. Twenty-three inputs are included, as are the production and consumption of 44 agricultural commodities and processed products (Table 5). Agricultural markets for inputs

<sup>3</sup>To keep our results representative of the adult U.S. population, we use the appropriate NHANES sample weight for each observation. For presentation, the tails of the distributions are not included in the figures.

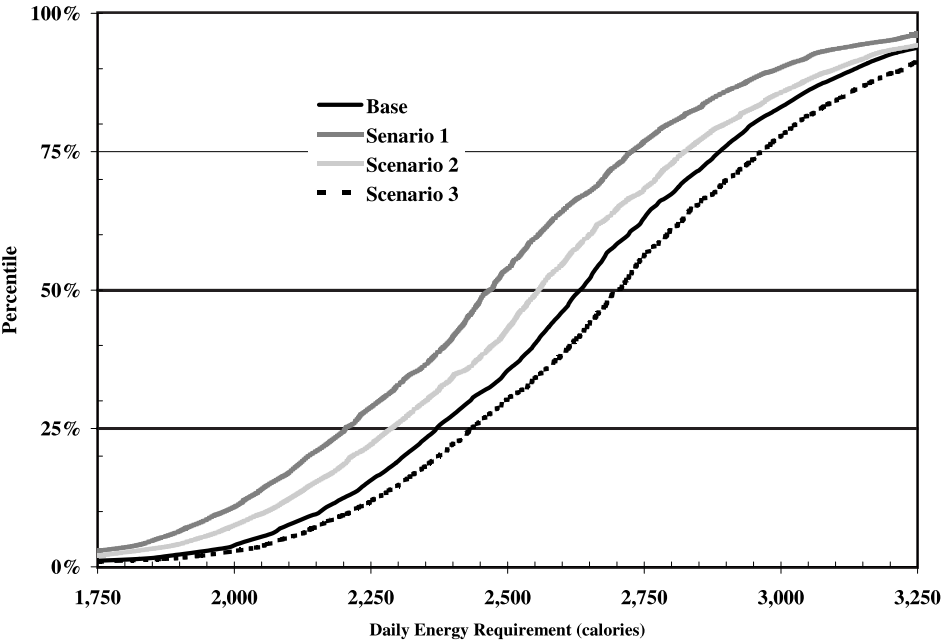


Figure 1 Distribution of men's daily energy intake.

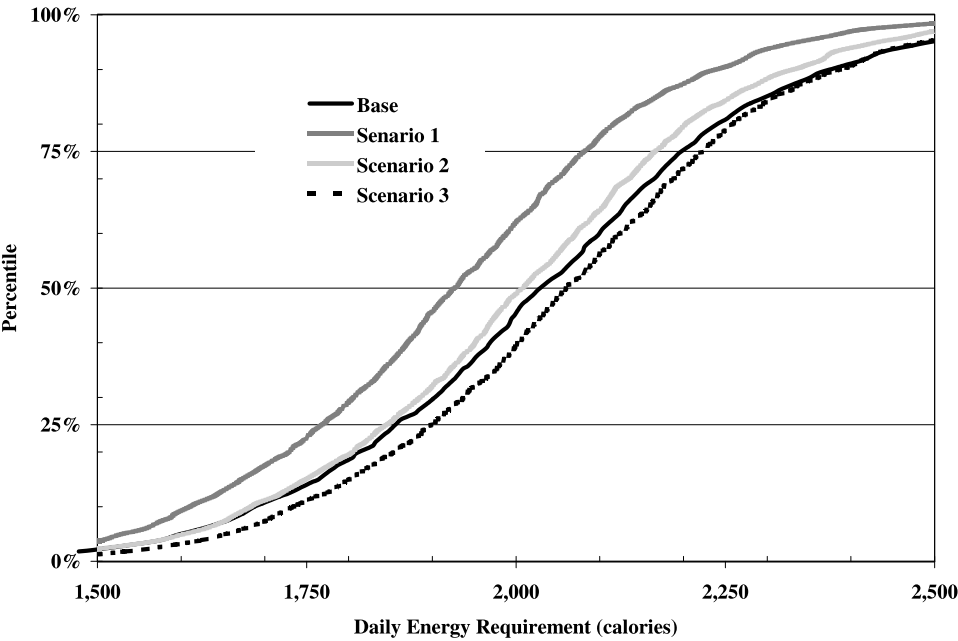


Figure 2 Distribution of women's projected daily energy intake.

TABLE 4. Estimated Changes in Domestic Consumption (%)

Scenario	Description	Total	Men	Women
Sc1	Meet DHHS recommendations with no change in physical activity	−5.75	−5.26	−6.13
Sc2	Meet DHHS recommendations with small increase in physical activity	−2.05	−2.68	−1.23
Sc3	Obesity trends continue with no change in physical activity	2.11	2.68	1.37

such as land (crop and pasture), labor (family and hired), and irrigation water are specified at the regional level, and the demand for roughly 23 other inputs (e.g., fertilizer and seed) are subject to fixed, national prices.

Production levels and enterprises are calibrated to regularly updated production practices' surveys using a positive math programming approach (Howitt, 1985) and the USDA multiyear baseline (USDA, 2003). Regionally specific extensive (animal and crop production levels) and intensive (crop rotations, tillage, and fertilizer practices) management practices are endogenously determined. Substitution among the cropping activities is achieved in the model using nested constant elasticity of transformation functions. The model's nonlinear supply response functions reflect declining marginal rates of transformation between crop rotations and between tillage activities. This implies that changes in various production enterprises do not occur in a "bang-bang" fashion as in linear programming, but will smoothly adjust to changes in relative returns across production enterprises.

TABLE 5. Input and Outputs for Simulation Model

Regional	Inputs		Outputs	
	National	Crops	Livestock	Processed
Cropland	nitrogen fertilizer	corn	fed beef for slaughter	soybean meal
pasture land	potassium fertilizer	sorghum	nonfed beef for slaughter	soybean oil
	potash fertilizer	barley	beef calves for slaughter	livestock feed mixes
	lime	oats	beef feeder yearlings	dairy feed supplements
	other variable costs	wheat	beef feeder calves	swine feed supplements
	public grazing land	cotton	cull beef cows	fed beef
	custom farming operations	rice	cull dairy cows	nonfed beef
	chemicals	soybeans	cull dairy calves	veal
	seed	silage	milk	pork
	interest on operating capital	hay	hogs for slaughter	broilers
	machinery and equipment repair		cull sows for slaughter	turkeys
	veterinary and medical costs		feeder pigs	eggs
	marketing and storage			butter
	ownership costs			american cheese
	labor and management costs			other cheese
	land taxes and rent			ice cream
	general farm overhead			nonfat dry milk
	irrigation water application			manufacturing milk
	energy costs			ethanol
	insurance			corn syrup

TABLE 6. Price and Quantity Changes Adjusting for Changing Domestic Caloric Intake\*

Commodity	Elasticities <sup>b</sup>		Change in price (%)			Change in production (%)		
	Consumption	Trade	scenario 1	scenario 2	scenario 3	scenario 1	scenario 2	scenario 3
Eggs (doz)	-0.06	0.00	-2.99	-1.07	1.10	-5.61	-2.00	2.06
Broilers (bs)	-0.54	-12.60	-1.34	-0.48	0.49	-2.00	-0.71	0.74
Turkeys (lbs)	-0.42	-12.60	-2.06	-0.73	0.75	-2.99	-1.10	1.10
Fluid Milk (lbs)	-0.28	0.00	-4.46	-1.59	1.63	-5.75	-2.05	2.11
Cheese (lbs)	-0.33	0.00	-4.23	-1.50	1.54	-5.75	-2.05	2.11
Ice Cream (lbs)	-0.12	0.00	-5.28	-1.88	1.93	-5.77	-2.06	2.12
Fedbeef (cwt)	-0.73	0.00	-0.97	-0.34	0.35	-1.40	-0.51	0.57
Pork (cwt)	-0.80	0.00	-0.48	-0.17	0.18	-4.81	-1.70	1.75
Corn (bu)	-0.06	-1.70	-2.06	-0.74	0.75	-1.75	-0.63	0.65
Wheat (bu)	-0.05	-4.11	-1.27	-0.46	0.48	0.06	0.05	-0.07
Rice (cwt)	-0.07	-34.33	-0.33	-0.12	0.12	1.19	0.40	-0.40

\*Scenario 1 = reduced caloric consumption and no change in physical activity; scenario 2 = reduced caloric consumption and increased physical activity; scenario 3 = increased consumption and no change in physical activity.

<sup>a</sup>Changes in prices and production for selected commodities are in reference to the USDA projected baseline for 2010 (USDA, World Agricultural Outlook Board, 2003).

<sup>b</sup>Selected baseline elasticities are arc elasticities generated from price shocks introduced into the USDA Food and Agricultural Policy Simulator (Westcott, Young, and Price, 2002) and the Partial Equilibrium Agricultural Trade Simulator (Abler, 2006). Elasticity values of zero indicate products that are generally traded in small quantities relative to other products. In these cases, an import elasticity of 0.01 and export elasticity of -0.01 are assumed.

Domestic consumption shocks are simulated for commodity prices and production levels at the regional level, which are integrated into the flow of final commodity markets.<sup>4</sup> The consumption and trade elasticities (Table 6) are specified so that model supply response at the national level for the medium term is consistent with domestic supply response in the USDA's Food and Agriculture Policy Simulator (Westcott, Young, & Price, 2002) and with trade response in the Partial Equilibrium Agricultural Trade Simulator (Abler, 2006).

#### 4. RETURNS TO PRODUCTION MIRROR CHANGES IN CONSUMPTION

It is not surprising that U.S. commodity production and price fall under Scenarios 1 and 2, where U.S. consumers reduce caloric intake and demand less food (Table 6). However, production, for the most part, does not fall by as much as the domestic demand shock. This is because the amount of commodities exported and commercial stocks generally increases. These results are consistent with Kantor (1998), who noted that a movement towards eating habits implicit in the food pyramid, would likely result in decreased prices and production for feed grains (e.g., soybeans) and high-fat animal products, but a corresponding increase in exports of these commodities. The resulting increase in commercial stocks in the medium term, reflects a relatively inelastic acreage supply response to changes in domestic demand, but would not be expected to continue over the long term due to lower prices.

<sup>4</sup>The consumption shocks estimated for Scenarios 1–3 are exogenous to the model; i.e., price changes induced by adjusting to these consumption shocks do not then, in turn, result in secondary consumption adjustments.

TABLE 7. Changes in Returns to Agricultural Production (Millions \$2004)

Scenario <sup>a</sup>	Region <sup>b</sup>										
	NE	LA	CB	NP	AP	SE	DL	SP	MN	PA	US
Scenario 1	-426	-534	-703	-369	-377	-180	-140	-185	-289	-442	-3,644
Scenario 2	-153	-190	-253	-132	-135	-65	-50	-67	-102	-159	-1,306
Scenario 3	160	197	263	136	141	68	52	71	106	166	1,359

<sup>a</sup>Scenario 1 = reduced caloric consumption and no change in physical activity; scenario 2 = reduced caloric consumption and increased physical activity; scenario 3 = increased consumption and no change in physical activity.

<sup>b</sup>Northeast (NE) = CT, DE, MA, MD, ME, NH, NJ, NY, PN, RI, VT; Lake States (LA) = MI, MN, WI; Corn Belt (CB) = IA, IL, IN, MO, OH; Northern Plains (NP) = KS, ND, NE, SD; Appalachia (AP) = KY, NC, TN, VA, WV; Southeast (SE) = AL, FL, GA, SC; DELTA = AR, LA, MS; Southern Plains (SP) = OK, TX; Mountain States (MN) = AZ, CO, ID, MT, NM, NV, UT, WY; Pacific (PA) = CA, OR, WA; United States (US).

Net returns to agricultural production fall most under scenario 1, when U.S. consumers meet the Surgeon General's recommendations only by reducing the amount of calories consumed (Table 7). Nationally, net returns to agricultural production could fall annually by as much as 6.7% or \$3.6 billion, spread across the 10 U.S. farm production regions. Under Scenario 2, the direction of these effects is the same; however, the magnitude of these effects is reduced. Under Scenario 3, where weight gain in the United States parallels obesity trends over the last decade, increased production of major commodities and increased prices are estimated to keep pace with the aggregate increase in caloric demand. Net returns to agricultural production could increase by as much as 2.5% or \$1.4 billion, and acres cropped could increase by 0.6%. Regionally, under all scenarios changes in returns to agricultural production are largest (as a percentage) in the Northeast and smaller in the Southern Plains. In value terms, changes are more pronounced in agriculturally intensive areas such as the Corn Belt and Lake States.

## 5. DISCUSSION

Between 1890 and 1990, the U.S. government promoted food consumption, with the goal of addressing dietary deficiencies and chronic diseases (Nestle, 2002). Now, government food consumption policy has turned away from the "eat-more" mode towards a position that advocates avoiding excessive portions coupled with a regime of moderate exercise (see, for example, the HealthierUS initiative; The White House, 2003) in an effort to reduce the number of Americans that are overweight or obese. We find that the transition to an eat less—exercise more paradigm may have significant implications for U.S. producers and for consumers.

However, aggregate domestic consumption and exercise patterns do not need to change substantially to address the overweight and obesity epidemic facing the United States today. With modest changes in aggregate caloric intake, U.S. consumers can achieve the goals outlined in the Surgeon General's recommendations for 2010. An aggregate reduction in caloric consumption of 5.75% implies that the average man and woman in our sample would consume about 170 and 110 fewer calories each day (note that within the population distribution, there will be men and women who reduce consumption by more and less than the average levels). If consumers increase their levels of physical activity,

the requisite reduction in average caloric demand falls to only 2%, or about 80 and 30 fewer calories per day for the average man and woman, respectively. Conversely, we find that small behavioral changes in the opposite direction can lead to significant increases in populations' rate of overweight and obesity. If men and women eat, on average, 70 and 87 more calories a day, the percentage of the adult population with a healthy bodyweight falls to less than 25%.

We do not mean to imply that changes in consumption and exercise habits are easy to achieve, if they were, obesity would not likely be such a problem. Nevertheless, small changes in domestic consumption can, however, have measurable impacts on the returns to agricultural production. In general, reduced commodity demand would translate into reduced agricultural production and commodity prices. Subsequently, net returns to producers may decline by between 2% and 7% under our conservative assumptions. On the other hand, reduced agricultural production could result in reduced environmental impacts associated with the process of cultivating crops and feeding livestock. Regionally, impacts on production were largest in the Corn Belt and Lake States. In summary, the results indicate that reductions in aggregate domestic caloric consumption would result in lower commodity prices and decreased farm incomes. These results would likely be muted if consumers supplement dietary restrictions with increased physical activity, and reversed if current overweight and obesity trends continue.

However, to meet the most recent dietary guidelines (USDHHS, 2005), we know that in addition to maintaining proper energy balance, Americans would still need to increase consumption of fruits, vegetables, and whole grains (as in Buzby et al., 2005), and limit their intake of enriched grains, solid fats, and added sugars. Thus, an extension of this research would be to analyze how changing diet composition along with changing levels of caloric intake may affect agricultural production and environmental quality. Incorporating production of fruits, fish, and other vegetables in our models would enrich our estimates of agri-environmental impacts of reducing obesity in the United States.

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## REFERENCES

- Abler, D. (2006). Partial Equilibrium Agricultural Trade Simulator: Online documentation. Retrieved September 6, 2006, from <http://trade.aers.pso/index.cfm/>
- Buzby, J.C., Farah, H., & Vocke, G.. (2005). Will 2005 be the year of the whole grain? *Amber Waves*, 3(3), 13–17.
- Centers for Disease Control and Prevention. (2003). 1999–2000 National Health and Nutrition Examination Survey. Hyattsville, MD: U.S. Department of Health and Human Services, National Center for Health Statistics.
- Faeth, P. (1995). *Growing green: Enhancing the economic and environmental performance of U.S. Agriculture*. Washington, DC: World Resources Institute.
- Food and Nutrition Board, Institute of Medicine. (2002). *Dietary reference intakes for energy, carbohydrates, fiber, fat, protein and amino acids*. Washington, DC: The National Academy Press.

- House, R.M., McDowell, H., Peters, M., & Heimlich, R. (1999). Agriculture sector resource and environmental policy analysis: An economic and biophysical approach. In V. Barnett (Ed.), *Environmental statistics: Analyzing data for environmental policy* (pp. 243–261). New York: Wiley.
- Howitt, R.E. (1995). Positive mathematical programming. *American Journal of Agricultural Economics*, 77, 329–342.
- Johansson, R.C., Cooper, J., & Vasavada, U. (2005). Greener acres or greener waters? U.S. adjustments to agricultural trade liberalization. *Agricultural and Resource Economics Review*, 34, 42–53.
- Kantor, L.S. (1998, December). A dietary assessment of the U.S. food supply: Comparing per capita food consumption with food guide pyramid serving recommendations (ERS Agricultural Economic Report No. 772). Washington, DC: U.S. Department of Agriculture, Economic Research Service.
- McCrary, M.A., Hajduk, C.L., & Roberts, S.B. (2002, December). Procedures for screening out inaccurate reports of dietary energy intake. *Public Health Nutrition*, 5, 873–882.
- McNamara, P.E., Ranney, C.K., Kantor, L.S., & Krebs-Smith, S.M. (1999). The gap between food intakes and the yramid recommendations: Measurement and food system ramifications. *Food Policy*, 24, 117–133.
- Mokdad, A., Marks, J., Stroup, D., & Gerberding, J. (2005). Correction: Actual causes of death in the United States, 2000. *Journal of the American Medical Association*, 293, 293–294.
- Nestle, M. (2002). *Food politics*. Berkeley, CA: University of California Press.
- Palaniappan, U., Cue, R.I., Payette, H., & Gray-Donald, K. (2003). Implications of day-to-day variability on measurements of usual food and nutrient intakes. *Journal of Nutrition*, 133, 232–235.
- Peters, M., Lewandrowski, J., House, R., & McDowell, H. (2001). Economic impacts of carbon charges on U.S. agriculture. *Climatic Change*, 50, 445–473.
- Stout, J., & Abler, D. (2003). ERS/Penn State WTO model documentation. Retrieved February 7, 2005, from <http://trade.aers.psu.edu/documentation.cfm>
- Surgeon General. (2004). Overweight and obesity fact sheet: At a glance. Retrieved February 7, 2005, from [http://www.surgeongeneral.gov/topics/obesity/calltoaction/fact\\_glance.htm](http://www.surgeongeneral.gov/topics/obesity/calltoaction/fact_glance.htm)
- U.S. Department of Agriculture, Center for Nutrition Policy and Promotion. (2004). The food guide pyramid update. Retrieved February 7, 2005, from <http://www.usda.gov/cnpp/pyramid-update/FGP%20docs/TABLE%202.pdf>
- U.S. Department of Agriculture, World Agricultural Outlook Board. (2003). USDA agricultural baseline projections to 2010 (Staff Report WAOB-2003-1). Washington, DC: U.S. Department of Agriculture, World Agricultural Outlook Board.
- U.S. Department of Health and Human Services (USDHHS) and U.S. Department of Agriculture. (2005, January). *Dietary guidelines for Americans, 2005* (6th ed.). Washington, DC: U.S. Government Printing Office.
- U.S. Department of Health and Human Services. (2000, November). *Healthy people 2010: Understanding and improving health and objectives for improving health* (2nd ed.). Washington, DC: U.S. Government Printing Office.
- Variyam, J.N. (2003, April). Factors affecting the macronutrient intake of U.S. adults. (ERS Technical Bulletin No. 1901). Washington, DC: U.S. Department of Agriculture, Economic Research Service.
- Westcott, P.C., Young, C.E., & Price, J.M. (2002, November). The 2002 Farm Act: Provisions and implications for commodity markets (ERS Agricultural Information Bulletin No. 778). Washington, DC: U.S. Department of Agriculture, Economic Research Service.
- The White House. (2003). *HealthierUS*. Retrieved April 30, 2004, from [www.whitehouse.gov/infocus/fitness/](http://www.whitehouse.gov/infocus/fitness/)
- Young, E.C., & Kantor, L.S. (1998, December). Moving toward the food guide pyramid: Implications for U.S. agriculture (ERS Agricultural Economic Report No. 779). Washington, DC: U.S. Department of Agriculture, Economic Research Service.

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